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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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THE FOURTH MEETING OF THE INTERNATIONAL ASTRONOMICAL UNION

By C. A. Chant

THE fourth General Assembly of the International Astronomical Union took place at Cambridge, Mass., September 2 to 9, 1932. Ordinarily there is an interval of three years between successive meetings, but the last previous one was at Leyden in 1928. The present meeting was deferred one year in order to allow its members to observe the solar eclipse on August 31, since its path of totality lay near the place of meeting. Indeed, many of the astronomers came directly from their observing stations to Cambridge.

There were about 225 in attendance, from 23 countries. This number includes wives and other accompanying guests. From the United States there were over 100; from Canada, 13. The latter were: R. Meldrum Stewart and Mrs. Stewart, C. C. Smith and Mrs. Smith, J. P. Henderson, Ottawa; Miss A. V. Douglas, Montreal; J. S. Plaskett and Mrs. Plaskett, W. E. Harper, C. S. Beals and Mrs. Beals, Victoria, B.C.; C. A. Chant and Mrs. Chant, Toronto.

The members and guests were mostly housed in the dormitories of Radcliffe College, while the sessions were held in Longfellow Hall, a recently constructed building of the College, a short distance from the residences. Much pleasant and important discussion took place in the lobbies, on the piazzas and on the streets.

steamer across Boston Harbour and along the western shore of Massachusetts Bay to Plymouth, the site of the first Pilgrim colony in America, 1620. The party, about 200 strong, had dinner at the Pilgrims Hotel, and after a brief visit to Plymouth Rock re-embarked for Boston and thence by buses to Cambridge. On the way back the time was spent in pleasant games and dances (square, waltz, folk and modern) in the saloon and in conversations amongst old and new-made friends.

By invitation of President Karl T. Compton, the Walker Memorial Hall of the Massachusetts Institute of Technology was open on Wednesday evening for a lecture by Sir Arthur Eddington on "The Expanding Universe". It was a great pleasure to hear his brilliant (and often amusing) exposition of this subject, to which he himself has contributed so much. The demand for tickets for this lecture was unprecedented in the history of the Institute, and an overflow audience in a separate hall was served by loud speakers.

On Thursday morning there was a general assembly; and in the afternoon an excursion to Wellesley College, one of the foremost colleges for women in the United States, some fifteen miles west of Cambridge. The visitors were received at the well-equipped and finely-kept Whitin Observatory by Director J. C. Duncan and Mrs. Duncan. Then a visit was made to Tower Court, one of the numerous fine buildings of the college, where they were received by Miss Ellen F. Pendleton, president of the college. The grounds, buildings and equipment of the college were greatly admired.

In the evening a formal dinner was provided by the American section of the Union in the large dining room of the Hotel Continental, Cambridge. Professor H. N. Russell ably presided as toastmaster and addresses were made by Sir Frank Dyson; Professor Esclangon, director of the Paris Observatory; Professor and Mrs. Abetti of the Arcetri Observatory, Florence; Mr. R. M. Russell, Mayor of Cambridge; Professor W. S. Adams, director of the Mount Wilson Observatory; and Professor Shapley, director of the Harvard Observatory. The guests were distributed to the tables in a random manner, so that many new contacts were made and pleasant friendships begun.

For the special entertainment of the ladies there were two excursions. One was a trip of an hour and a half on the Charles River, with tea at the home of Professor and Mrs. Kennelly; the other, a visit to the University Museum, the Germanic Museum and the Fogg Art Museum, followed by tea at the Faculty Club.

The general assembly convened on Friday morning to consider further reports from commissions, and to finish the business of the meeting. It was decided to accept the invitation of Professor Esclangon and hold the next meeting at Paris. Professor Frank Schlesinger, of Yale Observatory, was chosen next president, and the vice-presidents are: Professors Banachiewicz (Poland), Fabry (France), Nörlund (Denmark), Bianchi (Italy) and Nusl (Czecho-Slovakia). Professor F. J. M. Stratton, of Cambridge University, England, was re-elected general secretary.

The chairmen of the sub-committees of the local committee were: Reception, B. J. Bok; Registration, L. B. Andrews; Finance, W. J. Fisher; Housing, F. L. Whipple; Excursions, L. Campbell; Information, B. J. Bok; Press, Miss C. H. Payne; Women, Mrs. H. Shapley. The chairman of the local committee was Harlow Shapley and the secretary was L. B. Andrews. Addresses of appreciation of the labours of the local committee were made by Sir Frank Dyson, Professor Esclangon, Professor Nörlund, and, on behalf of the ladies, by Lady Dyson.

At noon on Friday the meeting of the Union was over. A number of the members, chiefly from great distances, remained a day longer to discuss problems relating to the stellar universe, but the majority left at once by ship, railway or automobile.

THE SPECTROSCOPIC ELEMENTS OF THE ECLIPSING VARIABLE TX URSAE MAJORIS

By J. A. Pearce

THE seventh magnitude star, B.D.+46°.1659, H.D.93033, in Ursa Major was discovered to be an eclipsing variable independently by Rügemer[1] and Schneller[2]. A provisional period of 3.06199 days was found by Rügemer[3], who gives the visual amplitude as $6^m.87$ to $9^m.1$. A revised value of the period 3.063295 days was found by Jenka Mohr[4], from an examination of three hundred Harvard plates, covering the period 1903-1931. The deduced period satisfactorily represented the observations of the twenty-three minima observed.

This star was discovered to be a spectroscopic binary by the writer in 1925 from seven spectrograms taken during 1924-1925, which gave a range of over 100 km./sec. No attempt was made at the time to find the period, as the observations were scattered. Upon reading Mohr's article it was seen that the velocities were well represented by his period, and well distributed along the curve. Preliminary elements were readily found by the graphical method used at the observatory.

Seven additional spectrograms of this star were obtained last year by Dr. F. S. Hogg, who very kindly placed the plates at my disposal. All the observations and their representations are given in Table 1, the columns of which are self-explanatory. The phases are taken from periastron passage J.D.2423856.746. With two exceptions, the short-focus camera giving a dispersion of 49A per mm. at Hγ was used. The plates used for the first seven observations were Eastman 40 emulsion, and for the last seven Barnet emulsion.

The spectrum of the brighter star, which alone appears on our plates is of spectral type B9. Only the strongest and best of the lines were measured for radial velocity. These included λλ 4481 Mg II, 4471 He, 4026 He, Hγ, Hδ and K line of Ca II. A number of faint lines of ionized iron, titanium and chromium such as λλ 4549, 4351, 4233, 4130, 4128 and 4045 occur, but these in general were too ill-defined for accurate measurement. All of the plates were meas-

ured by the writer, some of them twice, on account of the diffuse nature of the lines.

The period of Mohr, 3.063295 days was found to satisfy the observations within their accidental error. The observations extend

TABLE I

OBSERVATIONS AND REPRESENTATIONS

No.	Julian Date 2,420,000+	Final Phase	Vel.	(O−C)	Lines	Remarks
1	3856.828	0.082	−13.5	+1.7	7	IM, g
2	3906.697	0.938	+34.0	+0.4	11	IM, g
3	4143.040	1.408	+ 8.3	−1.6	4	IS, p
4	4232.867	2.399	−57.1	+0.4	7	IS, g
5	4250.842	1.994	−34.1	−3.0	7	IS, g
6	4257.769	2.795	−57.6	+1.1	7	IS, g
7	4260.746	2.708	−63.6	−0.9	8	IS, g
8	6698.899	2.479	−59.8	+1.2	7	IS, f
9	6772.699	2.759	−62.9	−2.2	9	IS, g
10	6777.849	1.783	−10.6	+5.1	6	IS, f
11	6785.733	0.477	+25.6	−5.6	6	IS, g
12	6789.838	1.519	− 1.1	−3.8	8	IS, g
13	6817.746	1.857	−10.6	+1.5	8	IS, g
14	6828.783	0.641	+42.6	+5.5	5	IS, p

IM = Medium-focus camera, 29A per mm. at Hγ
IS = Short-focus camera, 49A per mm. at Hγ
g = good, f = fair, p = poor

over 8 years, some 970 revolutions. This period was adopted as final and omitted from the least-squares solution. The observations were weighted equally. The solution of the resulting normal equations gave the following small corrections to the preliminary elements:

$\delta\gamma = +1.34$ km./sec $\quad \delta\omega = -2°.20$
$\delta K = +0.69$ km./sec $\quad \delta T = -0.027$ days
$\delta e = +0.005$

The final elements together with their probable errors are given in Table II. The least-squares adjustment reduced the Σpvv by 17 per cent. The probable error of a single observation of weight unity is ± 2.53 km./sec. The plotted observations shown in the velocity diagram have radii corresponding to this value.

TABLE II

SPECTROSCOPIC ELEMENTS H.D. 93033

		Preliminary	Finals
Period	P	3.063295	3.063295 days
Eccentricity	e	0.20	0.205 ± 0.022
Longitude of Periastron	ω	255°	$252°.8 \pm 5°.27$
Periastron Passage	T	J.D. 2423856.773	3856.746 ± 0.044
Velocity of System	γ	-11.4	-10.1 ± 0.62 km./sec.
Semi-amplitude of Primary	K	50.0	50.7 ± 0.96 km./sec.

The mass function and projected semi-major axis of the orbit are:

$$\frac{m^3_2 \sin^3 i}{(m_1+m_2)} = 0.03888 \odot$$

$$a \sin i = 20{,}900{,}000 \text{ km.}$$

A light curve has not yet been published for this eclipsing star. The only information available is the depth of the principal minimum. A loss of light of 2.2 magnitudes, according to Rügemer, represents a fall of 88 per cent. of the total light. It is certain, therefore, that the smaller brighter star is almost totally eclipsed at principal minimum by the larger darker star, which contributes a maximum of 0.12 of the total light. Assuming that the smaller star is totally eclipsed, it is 6.6. times as bright as the larger star. Seen separately, the component stars would have apparent magnitudes of 7.05 and 9.1 respectively. Their combined apparent magnitude is 6.89.

An approximate value of the inclination may be found from the relation:

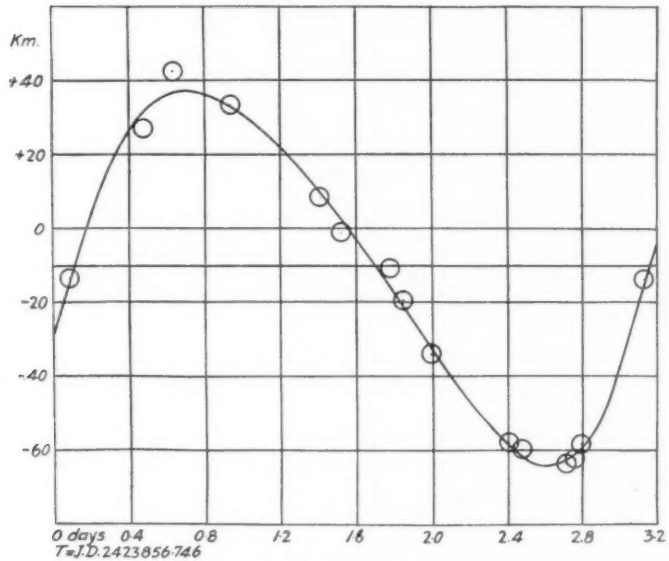
$$e \cos \omega = \frac{\pi}{P} \frac{(t_2 - t_1 - P/2)}{(1+\mathrm{cosec}^2 i)}$$

which leads to the value of 75°.7 for the orbital inclination.

Eclipses are predicted by the spectroscopic elements as follows:

Primary eclipse = J.D.2423858.494 + 3.063295 E

Secondary eclipse = J.D.2423856.841 + 3.063295 E



Radial Velocity Curve HD. 93033

The primary eclipse may, however, be partial in character, rather than total, and the residual light of 12 per cent. may still be largely contributed by the brighter star. One spectrogram, J.D.2426777.849, taken during primary eclipse has a B8 spectrum, quite similar to all the other plates. The secondary eclipse is probably too small to be detected, except by the most refined photometric observations.

The spectroscopic phase of the primary eclipse is 0.13 ± 0.06 days later than the observed minimum. Considering the nebulous nature of the spectral lines, this difference may reasonably be attributed to errors in the spectroscopic data, resulting from insufficient observations.

The star will be reobserved next spring, with higher dispersion, in order to detect a rotational effect if present, and to refine the spectroscopic elements. It is hoped that a light curve will soon be completed for this eclipsing variable.

Dominion Astrophysical Observatory,
Victoria, B.C.
September 1, 1932.

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[1]Rügemer, A. N., 242, 177, 1931.
[2]Schneller, A. N., 242, 180, 1931.
[3]Rügemer, Die Himmelswelt, 41, 189, 1931.
[4]Jenka Mohr, H. B., 885, 14, 1931.

A REPORT ON SOME OBSERVATIONS MADE IN CONNECTION WITH THE TOTAL ECLIPSE OF THE SUN, AUGUST 31st, 1932, AT MAGOG, QUE.

By C. B. Hutchings

WHILE en route to Quebec via Sherbrooke, Que., on August 31st, I stopped off at Magog in the early morning to make some observations on the total eclipse of the sun. I chose as my station a point two and one-half miles west of Magog, situated on R.M.D. No. 3—14th Range, on a hillside immediately south of and about 400 yards from the Hermit Inn, where the British and Virginian Expeditions were quartered. From there a clear and uninterrupted view was obtained of the hilly country to the north and west. Below was Lake Magog, and slightly to the right Mount Orford, the highest land in the vicinity, which lay by compass reading N.W. by N.

I set up my tripod and adjusted barometer, thermometer, watch and compass. The watch had been corrected at the Dominion Observatory's Time Room before leaving Ottawa, and was checked twice on the way down to Magog, with the Canadian Pacific Railway Conductor's time. A sheet for measuring light bands was placed on the ground near by and first readings of instruments made at noon.

The weather had been very uncertain all the morning. At times the sky cleared fairly well, only to be soon covered almost completely by large cumulus clouds. This condition occurred many times. As noon approached, however, it became evident that the chances of getting a clear, uninterrupted view of the sun were going to be very slim, and if sanguine possibilities were cherished earlier in the day for good observing conditions, these were now, unfortunately, to be dashed to the ground. The wind began to freshen considerably from the S.W. and heavy, lowering clouds rolled up from that direction, completely covering the heavens and shutting out every vestige of sunlight. Readings were taken every quarter of an hour. At 2.31 there was a slight

rift in the clouds for a very short duration, sufficient to allow me to see the dark edge of the moon on the western limb of the sun. This observation was made without the aid of coloured glasses and by means of prismatic binoculars of power 6. At 3.17 the clouds again thinned out enough to see the sun, which then was a narrow crescent and sufficiently bright to require a thin photographic film to be used with the binoculars, and I was fortunate to witness the final shutting out of the sun by the moon's body at 3.26 and to have the entire period of totality of 101 seconds passed under the same conditions, during which the corona appeared as a dull halo, the light fairly evenly disposed around the moon, except for a spot on the right upper limb which showed a slight prominence. No colouring was observed. Immediately the period of obscurity was ended the rays from the right limb of the sun shot down quite brightly, something after the nature of a searchlight and the darkness was at once dissipated. The clouds continued to remain tenuous, permitting the moon to be seen slowly drifting away westward over the sun's disc, each moment the sun becoming brighter, until at 3.31—a period of fourteen minutes—when they again thickened and cut off finally all view of the eclipse. I remained at my post until 4 o'clock, then returned to the railway station.

So far as could be observed, the barometric pressure was only slightly affected. The figures of 29.91, made on a D.L.S. Special Barometer (compensated for temperature) at noon, were reduced by one-tenth at the time of totality; but whether this change was due to the eclipse, or was brought about by the prevailing weather conditions, I cannot say.

The thermometer at noon stood at 79 F. As the afternoon began to wear on, the temperature fell gradually, until at the time of totality it reached 72 F.—a difference of seven degrees—which, I think, may be accounted for by the interception of the sun's rays by the body of the moon.

Biological Observations

In the immediate vicinity of my station were many wild cherry trees heavily laden with fruit. These attracted large flocks of birds, chiefly robins, starlings, blackbirds, and cedar wax-wings. Other

birds also observed in the near-by trees were flocks of crows, grackles, blue birds, and gold finches; also a yellow hammer, phoebe, downey woodpecker, Baltimore oriole, yellow warbler, and song sparrow. Many of the flocks were on the wing, flying in a southerly direction all the afternoon. Up to the time of the eclipse, bird life was exceedingly active everywhere. Many varieties were singing, or uttering calls and cries of various kinds; but as the darkness approached, all song and movement gradually ceased, until complete silence reigned. This was specially noticed during the period of totality. I could not see to read my instruments, or to write, and the highlands all around appeared in dull bluish outline. But as soon as the first rays of the sun shot out again at 3.27, immediately the birds began to show signs of activity and gradually they resumed flight. The flocks, however, were undoubtedly much disturbed and flew about in great confusion in all directions, as if startled by gun fire. This was particularly true in the case of the starlings and robins. Large numbers settled on the trees and bushes around, for a moment or two, only to be off again in very uncertain flight. These conditions, more or less, continued until I left the field at 4 o'clock.

It would seem, therefore, from the foregoing observations, that bird life is affected by a total eclipse of the sun, and that their song and flight are influenced considerably, specially during the period of totality.

STATEMENT OF OBSERVATIONS MADE ON AUG. 31ST, 1932, AT MAGOG, QUE. BY C. B. HUTCHINGS, OF OTTAWA

East. Std. Time	Barometer	Thermometer	Wind	Clouds	Remarks
12.00	28.92	79F	S.W.	Heavy stratus	
12.30	.91	79	good breeze		
12.45	.91	77	Falling away	Dark stratus gathering from W. Clear in patches at north	
1.00	.91	75	Wind rising again		
1.15	.91	78	Heavy clouds coming up from S. W.		
1.30	.91	77			

1.45	.91	77	Patch of blue sky in N. W.
2.00	.91	76	Sun exposed for short duration
2.15	.91	75	Completely overcast
2.30	.91	75—	
2.31	—	—	Clouds lifted enough to see moon on right limb of sun
2.45	.91—	75—	Wind died away to calm.
3.00	.91—	74	Getting quite dark.
3.05	.91—	73	
3.15	.91—	72	
3.17	—	—	Clouds thinned out enough to see the eclipse well.
3.26	.90	72	Sun totally eclipsed. Unable to see to read. Mountains outlined
3.27	—	—	very dimly. All bird life silent.
3.27;40	—	0	Strong ray of sunlight shot out on right.
3.31			Sky again became heavily overcast and remained so for the rest of afternoon. Sun not seen again.
4.00			Left station.

A Note on Bird Life in Ottawa During Eclipse of Sun, made on August 31st, 1932

In Ottawa, at 223 Fourth Avenue, Glebe District, some observations were made on the sun's eclipse on August 31st. A clear, uninterrupted view of the sun was obtained during the whole period of the phenomenon. As the light began to fade, some house sparrows and robins settled on the electric wires near the house, and two of the sparrows flew down to a vine-covered pergola in the garden and prepared to rest, as for the night. Both were observed later to put their heads under their wings and appeared to go to sleep. Shortly after the light got stronger they wakened up and flew away.

Coloured streamers of orange and dull red were distinctly seen during the maximum period of totality.

Department of Agriculture,
Entomological Branch,
Ottawa, Ont.

NEW PLANETARY DISCOVERIES*

By Henry Norris Russell

THE discovery of minor planets has fairly been put on a basis of mass production.

In the old heroic days the observer, with great labour and pains, made himself a chart showing all the stars in some given region of the sky near the ecliptic; then he went over this region again and again comparing each star in his field of view with the chart. An interloper might be a variable star which had brightened up since the chart was made, or it might be a planet which had moved into the field. Only by later observations could it be told which of these discoveries had been made.

Now, of course, the discoverer works by photography. With a wide angle lens of large aperture—preferably a pair of them if he can afford the luxury—he makes an exposure of two or three hours, and obtains a plate which may show tens of thousands of stars. The average asteroid moves enough during such an interval to make its image a definite trail which can be picked out at once among thousands of point-images of stars. Defects on the plate, rare in any event, can be eliminated by means of a simultaneous exposure with the twin camera.

This method, as was once told in these columns, was invented by Prof. Max Wolf of Heidleberg and his observatory is still active above all others in this field. Dozens of new planetoids are found every year and those already known are picked up again at such a rate that, were all existing records destroyed, they could substantially all be rediscovered in a decade or two. Usually the newly found bodies are of no special interest—just one more bit of work for the observer who measures their positions and the computer who works out the orbit. But once in a while it still proves true that "there are as good fish in the sea as ever were caught".

On March 12 of the present year E. Delporte of the observatory of Uccle, in Belgium, found on one of his plates the trail of an

*From *Scientific American*, September, 1932.

object which attracted attention at once by its unusually rapid motion—nearly two degrees a day in a northeasterly direction. This suggested a comet, for most planets when in opposition to the sun, as this object nearly was, are moving eastward in space slower than the earth and so seem to drop back to the westward. Even with powerful telescopes, however, it presented the sharp starlike appearance of an asteroid and when a really reliable orbit could be calculated it turned out indeed to be one. Several computers have derived orbits which agree so well that there is no doubt left that the period is close to 2.7 years, the inclination 12 degrees, and the eccentricity of the orbit 0.44. The planet's greatest distance from the sun is 259,000,000 miles and the shortest distance 100,800,000 miles—only 8,000,000 miles greater than that of the earth. At this point—the point marked P in Figure 1—the planet's orbit is about

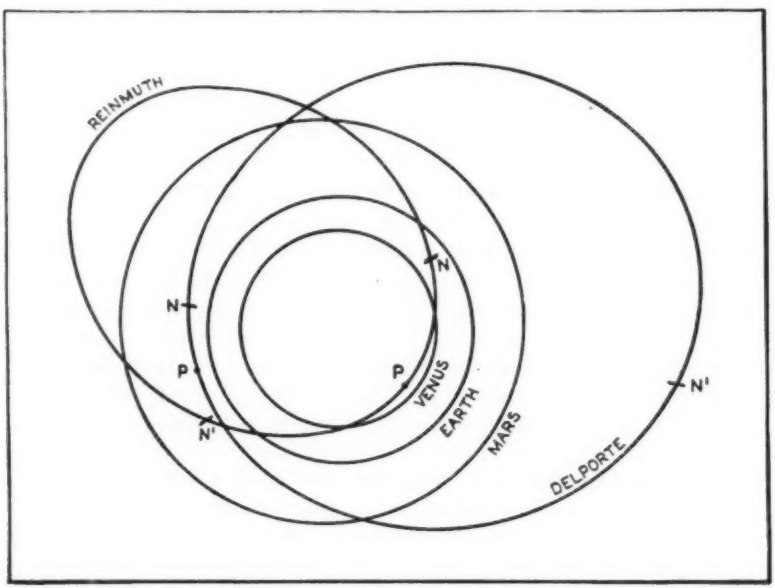

FIG. 1. Orbits of the earth, Venus, Mars, and the newly discovered asteroids. *P* is perihelion, N is ascending and N' descending node. The sun is at the centre of the orbit of Venus.

9,000,000 miles north of the plane of the earth's orbit. The closest approach of the two orbits comes nearly half way between the points N (the node) and P (perihelion), at a distance of 9,500,000 miles.

This was very nearly the situation of the two bodies ten days after the discovery. They were then almost in line with the sun—the asteroid about a degree ahead—and only 10,000,000 miles apart. The little planet moved fast in this part of its orbit—a little faster than the earth—so that the two *kept* almost in line with the sun as they moved around it, the planet gaining a little, as shown by its apparent motion. As it receded from the sun its motion slowed, and the earth caught up with it again on June 9. But by this time the two were 33,000,000 miles apart.

This interesting object should be observable for two or three months to come, though as it recedes it will become very faint, and before it is lost to sight there should be material for calculating a really reliable orbit. When next it comes into opposition in October, 1933, it will be on the far side of its orbit, about 250,000,000 miles from the sun and 160,000,000 miles from the earth, and it will look only 1/1700 as bright as it did this spring. It was then of the 12th or 13th magnitude and next time will be of the 20th or 21st. This is less than 1/100 as bright as Pluto, and just at the limit of faintness which can be detected by long exposures with the greatest telescopes. It is therefore very improbable that the new asteroid will be observed again until another favourable opposition occurs and, by that time, it may be lost unless unusually careful observations are made as long as possible.

It is easy to understand why it was not picked up before, but it is a great pity that it was not, for it came nearer us this spring than any known planet ever was before. By a suitable campaign of observations from different parts of the earth its distance could have been determined with even a greater percentage of accuracy than that of Eros the year before, and the scale of the whole solar system still more precisely defined. We may have to wait many, many years before so favourable a chance happens again.

The second object, discovered at Heidleberg by Reinmuth on April 24, is still more remarkable. It was moving westward in the heavens, but at the unusual rate of more than a degree a day, and

was therefore carefully observed. The early orbits by different computers agree closely enough to make it clear that at perihelion this body comes far inside the orbit of the earth, and even within that of Venus. The period is about 1¾ years and the inclination of the orbit small—only six degrees. Like Delporte's asteroid it was very near the earth when discovered, and came a little closer soon after. It was in opposition on April 23rd, at a distance of 17,000,000 miles. On May 15 it reached its minimum distance—only 6,000,000 miles! On June 4 it was in conjunction with the sun and about 15 degrees south of it in the heavens!

This body is still more likely to be lost after the present apparition and it is to be hoped that observations will be continued as long as possible. Its appearance shows that it is a *planet,* not a comet.

These two new planets must be among the tiniest bodies known to astronomy. Our only way to guess at their size is by the amount of light which they reflect. If we assume the low reflecting power of the moon, Delporte's planet comes out rather less than one mile in diameter and Reinmuth's a little smaller. With the high albedo of the asteroid Vesta they come out only half as big. If such an object could be let down gently on the earth's surface it would be no bigger than a fair-sized mountain.

There must be enormous numbers of these small asteroids. At ordinary distances of a hundred million miles or more they stand no chance of being detected. Only those which happen to come very near the earth's orbit are discoverable, and then only when all circumstances conspire to produce an actual close approach to our planet. Yet two of them have been found in a single year! We may expect further discoveries of the same sort now and then for decades to come.

AN ENGINEER'S OUTLOOK

Extracts from the address of Sir Alfred Ewing, as president of the British Association for the Advancement of Science, at the York meeting, 1932.

A NOTABLE event of the year is the strong evidence which Dr. Chadwick, of the Cavendish Laboratory, has found for the existence of what is called the neutron—a type of particle in which an electron and a proton are associated in particularly close juxtaposition. There is a like close association between electrons and protons in the nucleus of any heavy element, but it had not previously been discovered in a single isolated pair. Twelve years ago Lord Rutherford conjectured the existence of such a particle and described the properties it should possess. Its excessive smallness and density, together with its lack of an external electric field, give it a unique power of penetrating matter. It is too slim to be confined under pressure in any vessel: it will simply slip through the walls. The normal hydrogen atom has the same two constituents, one proton and one electron, but in nothing like the same intimacy of association, for the hydrogen atom wears its electron as a bulky crinoline which confers on it an immensely greater volume. The neutron, on the other hand, may be said to have taken the crinoline off, folded it up and put it in its pocket. Not to be too fanciful, we may at least describe the partners as clasping one another so tightly that the electron has ceased to be a fender; none the less as a unit of negative electricity it still serves to give electrical balance to the pair. Though so close together, the two constituents of the neutron remain separate and distinct, parted by nearly as many million volts as in a hydrogen atom. In this hitherto unknown particle, whose existence the experiments of Dr. Chadwick seem to have definitely proved, we have a new physical entity of extraordinary interest and a powerful tool for further research.

Lord Rutherford was the first to discover and name the nucleus. It is the inner sanctuary of the atom, the repository of secrets, many of which have yet to be disclosed, almost unapproachable, not only because of its smallness, but because of the electric field in which it is encased. Recognizing the nucleus to be a richly

charged strong-room, Rutherford has spared no effort to break it open. He has submitted it to a furious bombardment, using as missiles the alpha particles which radioactive substances project. These particles, each consisting of four protons and two electrons compactly built together, have the necessary velocity and energy to penetrate to the atom's heart. Rutherford had perforce to fire into the brown: he could not aim his gun, nor even tell when it would go off: the chances of a hit were no more than one in many millions. But hits were in fact obtained—hits so effective that they chipped off protons and caused the missile to be absorbed, thus realizing the dream of the alchemist by making one element change into another. That was a dozen or more years ago: since then his attack has lost none of its severity. It has been taken up under his guidance by a school of workers and many further secrets of the nucleus have been revealed.

Quite recently two of his disciples have gone one better, as disciples sometimes do, to the joy of their lords. Dr. Cockcroft and Dr. Walton have used missiles of their own making, instead of those that come spontaneously and intermittently from substances such as radium or thorium. By beautiful devices they have applied their knowledge of electrical engineering and their mastery of electrical technique to project single protons into the nucleus of lithium, using a steady potential of several hundred thousand volts to give the projectile sufficient penetrating power. An atom of lithium has (usually) seven protons and four electrons in its nucleus; the other three electrons constitute the crinoline. Here again it was a case of firing into the brown—out of millions of shots a few reached their billet. When the projected proton forces an entry into the lithium nucleus it creates a domestic disturbance of the liveliest kind. For with the seven protons already in occupation it makes an eighth; the group then splits into two sets of four, each taking two of the electrons, and they fly violently apart with an energy drawn from the atomic magazine. The result is that two helium atoms are formed. This is a notable achievement, the first artificial splitting of the atom by a laboratory process in which there is no recourse to the violent projectiles which radioactive

substances provide. It has been followed up by successfully applying the same method to break up the atoms of other elements.

It is a satisfaction to learn that in all the encounters and emissions and absorptions that are studied among atoms and protons and the parts of atoms there is, so far as we yet know, strict compliance with the accepted principles of conservation in respect of momentum and energy and mass, though matter (in the ordinary sense) is liable to transformation into energy and energy into matter. When radiation is emitted some matter disappears, for the atom that emits it loses a little of its mass; when radiation is absorbed a like quantity of matter comes into being.

But the engineer finds himself obliged to admit that no mechanical model of the atom can be expected to give an adequate picture of that strange new world. Our mechanical ideas are derived from the study of gross matter, which is made up of vast aggregates of atoms, and any model must share the limitations this implies. It it futile to explain the constitution of the atom in terms applicable to gross matter, just as it would be futile to study the psychology of an individual by observing only the movements of crowds. So we must expect fo find within the atom and among its parts qualities and actions different in kind from those we know, and paradoxes which without a wider vision we can not interpret. Such a paradox indeed confronts us at the present time, when we try to harmonize the wave aspect and the particle aspect of the proton, of the electron, and indeed of matter itself. These things are still a mystery—a riddle which some day we may learn to read. Meanwhile we do well to remember that any attempt to portray the structure of the atom in the language of ordinary experience is to give undue significance to symbols and analogies that are more or less invalid. Qualifying phrases like "so to speak" or "as it were" can not be escaped. They are confessions that the image is inevitably a distortion of the reality it is intended to suggest.

. . . . . .

One may safely say that there is no department of scientific endeavour our meetings have not aided, no important step in the procession of discovery they have not chronicled. It was at our

meeting of 1856 that Bessemer first announced his process of making a new material—what we now call mild steel—by blowing air through melted pig iron. Produced in that way, or by the later method of the regenerative furnace and the open hearth, it soon revolutionized the construction of railways, bridges, boilers, ships and machinery of all sorts, and it now supplies the architect with skeletons which he clothes with brick and stone and concrete. It was at the Oxford meeting of 1894 that Lodge demonstrated a primitive form of wireless telegraph based on the experiments of Hertz, a precursor of the devices that were brought into use a little later through the practical skill and indefatigable enterprise of Marconi. At the same meeting there was an epoch-making announcement by the late Lord Rayleigh. His patient weighings of the residual gas which was found after depriving air of all its oxygen led him to the discovery of argon. That was a surprise of the first magnitude; it was the herald, one may say, of the new physics. Next year his colleague Ramsay presented other members of the family of inert gases. It is curious to recall the indifference and scepticism with which these really great discoveries were received. Some of the chemists of that day seem to have had no use for inert gases. But the stones which the builders were at first disposed to refuse have become head stones of the corner. In the architecture of the elements they fill places that are distinctive and all-important; they mark the systematic sequences of the periodic law. In a metaphor appropriate to atomic physics we may describe them as coy ladies with a particular symmetry in their crinoline of electrons, unresponsive to advances which other atoms are ready to make or to receive. Inert though they be, they have found industrial uses. Helium fills airships; argon fills incandescent lamps; and neon, so modest a constituent of the atmosphere that you might think it born to blush unseen, has lately taken to blushing deliberately and even ostentatiously in the shop-signs of every city street. In the field of pure science it was neon, outside the radio-active elements, that first introduced us to isotopes. And helium has a greater glory as the key to radioactive transformations and historian of the rocks. Disciples of evolution should be grateful

to helium for delivering them from the cramping limits of geological time which an earlier physics had mistakenly imposed.

My own recollection covers many surprises that are become commonplaces to-day: the dynamo, the electric motor, the transformer, the rectifier, the storage battery, the incandescent lamp, the phonograph, the telephone, the internal combustion engine, aircraft, the steam turbine, the special steels and alloys which metallurgists invent for every particular need, wireless telegraphy, the thermionic valve as receiver, as amplifier, as generator of electric waves. To that last we owe the miracle of broadcasting. Who, a generation ago, would have imagined that a few yards of stretched wire outside the window and a magic box upon the sill should conjure from adjacent space the strains of Beethoven or Bach, the exhortations of many platforms, the pessimism natural to those who forecast the weather and the optimism of orators who have newly dined?

> Sounds and sweet airs, that give delight and hurt not.
> Sometimes a thousand twanging instruments . . .
> And sometimes voices . . . that, when I waked,
> I cried to dream again.

I don't know any product of engineering more efficient than that magic box. It needs no attention; it is always ready for service; and when you tire of it you have only to switch it off. A blessing on it for that! Heard melodies may be sweet, but those unheard are often sweeter. Do you ever reflect, when you pick and choose among the multitude of airs and voices, or shut out all from your solitude of thought, that they are still there, physically present, individual, distinct, crowding yet not interfering, besetting you though you do not perceive them, silent until you determine that one or another shall catch your ear? Go where you will, to the ocean or the wilderness or the pole, you can not escape that vast company of attendants; they come to you, unheard, unseen, from every quarter of the globe, with a swiftness no other messengers approach. Is any fairy tale so strange as that reality? In all the wizardry of science surely there is nothing more wonderful than this.

THE ECLIPSE

The God of Noon hath hid his face and veiled
His golden light behind the moon's broad shield.
The day grew wan and sickly, and the stars
Came forth in wonderment to view the scene,
Standing afar and silent, like grim wolves
Sensing the death-throes of their stricken prey.
The birds drop down upon the weighted boughs
With folded wings, in mute bewilderment.
The stupid cattle gaze with vacant stare
At the unwonted heavens, with low moans
And constant lowings at the unknown dread.
Great Caesar, faithful hound, who knows no fear
Of earthly man or beast, with shamed face,
Slinks to his sheltered kennel in dismay.
Here with low whines and long-drawn plaintive howl
He bays the ebon moon. Ourselves did gaze
With a new awe and reverence on the spheres
Moving in clouded majesty through space;
Feeling more near some fearful presence from
The unseen world around us hovering.
More weird and dark the ghostly shadows grew,
'Til hope had almost vanished in despair.
Deepened the purple gloom, the reeling world
Moved fitfully about in aimless round;
When, like some phantom from the vault of night,
Across our startled vision in a pall
Of final desolation and of death,
The shadow of the Sun-God swept the land.

And now the veil of night was slow withdrawn,
The grey dawn woke, and from the orbit's rim
The fire of God ran through the firmament,
Flooding the boundless reaches of the sky.

So comes the dawn of peace in hope and joy
When the red war-god calls his legions home.
So cometh war and peace, the chill grey breath
Of death,—life-giving light:—Pray God,
No more, no more shall men with maddened lips
Plunge the bright earth beneath war's dread eclipse.

ALEX. H. SUTHERLAND.

Victoria, Br. Col.

METEORS[1]

By A. Vibert Douglas

NATURE can furnish pyrotechnic displays on a far vaster scale than most people imagine, for although everyone from childhood is familiar with the "shooting star," as a meteor is often called, comparatively few people witness the periodic returns of meteor swarms which at certain seasons of the year and in certain parts of the sky present a striking display. Still fewer have been privileged to see the heavenly fireworks in all the glory of the displays of 1866, 1833, 1799 and earlier visitations.

In the early hours of November 12, 1799, the noted naturalist and explorer, Baron von Humboldt, records that for three or four hours the sky, as seen from the coast of Venezuela, was ablaze with hundreds and hundreds of meteors,—some faint, some outshining the planet Jupiter, some comparable only with the moon, many leaving trails of luminosity stretching over ten degrees of sky, others bursting like skyrockets, and yet others again going out as suddenly as they had appeared. About thirty-three years later this magnificent display was again seen, and once more in 1866, but since that time no such spectacular display has recurred, though each year, and particularly last autumn, they have been looked for.

Lesser swarms of meteors, however, are encountered by the earth at certain seasons each year, and observation has shown that if the tracks of the meteors seen at certain seasons be drawn on a chart of the sky the great majority will be found to have travelled in directions which appear to radiate from a definite point. Thus these November 9th to 16th meteors are called the Leonids since their radiant lies in the group of stars known as the constellation of Leo, the Lion; the Andromedes come towards the end of November, the Geminids are at maximum on December 11th, the Lyrids about April 21st. The August meteors are known as

[1]Broadcast by request of the National Council of Education over CKAC, Montreal, November 27, 1931.

Perseids because their radiant point is in the constellation of Perseus. Every year, about August 11th, these meteors are most abundant, and for several nights following this date, anyone interested in meteoric phenomena may be well repaid for spending an hour or more about midnight or better still in the early morning hours watching the sky and noting how many meteors appear, how great a variety and diversity of types there are, and whether their apparent paths if projected backwards do indeed point to the constellation of Perseus. In addition to these there are many other annual showers.

The question naturally arises as to what these meteors are. Direct knowledge of their substance is possible because occasionally one is seen to fall to the earth and many such meteorites have been found or dug up in various places. They are stony bodies, sometimes almost entirely iron-nickel alloy, varying in size from a grain of sand to a great mass of several hundredweights. In fact, in Arizona there is a huge meteor crater made, it is surmised, by the fall of an immense meteoric body of many thousand tons which has buried itself deep in the earth. There are no records as to when this fell. Most museums have specimens of meteorites, and it is noticeable how often the surface layer shows definite signs of intense rapid heating, so intense that fusion has resulted and so rapid that the great surface heat has not had time to penetrate far inwards. This heat is the result of friction. A stony fragment almost as cold as the outer space through which it has been moving, in some orbit probably about the sun, suddenly enters the earth's atmosphere and, caught in the gravitational field of the earth, it swoops downward through the air. So great is the velocity that the friction between its surface and the air molecules gives rise to sufficient heat to cause its surface to become luminous and glowing, yet in the upper atmosphere the air is not dense enough to carry off the heat thus produced. The vast majority of the meteors seen in the sky never reach the surface of the earth, being completely burnt up before ever gaining the lower regions of the atmosphere.

If a small portion or chip of a meteorite be fused in an electric arc in front of a spectroscope, a photograph may be obtained of the

spectrum of every element of which the meteorite is composed. Thus it has been proved that these bodies are composed of well-known elements—iron, nickel, cobalt, chromium, magnesium, sodium, calcium, silicon and also the less common terrestrial elements gallium and rubidium.

Much can also be learned by observation of the meteors which never reach the earth. Thus in 1798 two students of the University of Göttingen, Brandes and Benzenberg, stationed themselves a few miles apart each with a watch and a star chart on which he drew the path of every meteor observed, with a note of the time of appearance and duration of flight. Comparison of their records made possible a calculation of the distance of the meteors from the observers, the length of the path traversed in a known time and hence the speed of the meteor. The result of their investigation was to indicate that the average height of a meteor, when seen, is sixty miles. It is evident that higher accuracy may be obtained if photographic methods be employed. Several observatories have made extensive efforts to photograph meteors and much has been learned as a result of work in Russia, at the Harvard and Yale observatories, and in Great Britain.

In general, it may be said that the average meteor travels twenty-six miles per second, appearing as a luminous body at about 76 miles above the surface of the earth and disappearing at a height of 51 miles. The apparent track across the sky depends, of course, upon the direction of flight, being short if the meteor is approaching nearly head on, whereas if the flight is more nearly tangential, the path appears more elongated.

The apparent radiation of meteors from a certain constellation is entirely an effect of perspective; they have not actually come from those stars—the earth has, in fact, encountered a swarm of meteoric bodies travelling through space in roughly parallel paths. The study of the paths of meteor swarms has led to the interesting fact that certain swarms follow orbits like comets. The orbit of the Perseids seems to be that of a great comet of 1862 whose period is 120 years. This means that though the comet only passes near enough to the sun to be visible from the earth once in 120 years,

there is a certain amount of fragmentary matter distributed all along its great orbit, and since the earth's orbit overlaps the comet's orbit at a certain place each year, we encounter and capture some of these meteoric fragments. The Leonids are in the orbit of Tempel's comet of 1866, whose period is about 33 years, so that it will pass close to the sun next November; the Andromedes follow the orbit of Biela's comet, which, at its 1846 return, was seen to have disintegrated to a considerable degree and which since then has disappeared entirely, the meteor swarms being evidently the last remnants of the lost comet.

It has been estimated at Harvard Observatory that a thousand million meteoric particles, averaging 2 mg. mass each, fall into the earth's atmosphere every day. It is obvious how important a rôle is played by this protecting blanket of atmosphere which catches and vaporizes all but the exceptionally large meteors long before they reach the surface of the earth.

A Princeton astronomer has calculated that the meteoric bombardment of our sun augments its mass 60 tons per second; but when we remember that by reason of its out-pouring of radiation, light and heat, it is losing four million tons of mass per second, we realize that the infall of meteors is trifling indeed in comparison with the outflow of energy.

Some meteors of exceptionally high velocity, up to 100 miles per second, have in all probability come not from fragmentary matter describing orbits within our solar system, but from interstellar space. The earth revolves about the sun with an orbital velocity of about 18.5 miles per second, a body falling freely from outer space toward the sun would pass the earth's orbit travelling about 26 miles per second; thus a meteor with a much higher velocity must have in addition to the velocity imposed upon it by solar gravitation and by terrestrial gravitation when it got within close distance of the earth, a velocity of its own which has brought it across vast regions of space before it entered our solar system.

It is just because some meteors may give us information regarding far-off regions of space, that the study of meteors forms a definite branch of astronomy.

Meteorites were often regarded with superstitious awe and veneration in early times, and there are frequent references to them in historic records, particularly in early Chinese chronicles. In one of these it is recorded that on a dark night in the year 687 B.C. "stars fell like rain."

Pliny tells of a meteorite "as large as a cart" that fell in Thrace in 467 B.C. This became an object of worship in one of the Greek temples. A famous meteorite, weighing 260 lbs., no doubt of the Leonid swarm, fell in Alsace on November 7, 1492. It buried itself several feet deep in a wheat field, but it was dug up and placed in the church of the adjacent village by order of the Emperor Maximilian.

In conclusion, we should remember that meteors, no less than the greatest of the celestial bodies, give evidence of the essential oneness of the universe—atoms in the earth, in our sun, in a meteoric fragment or in a far-off star are all bound together in a great unity, being what they are and where they are because each is what it is and the law of its nature is a universal law of all nature.

A meteor may be a very small fragment of matter in this vast universe, shining for but a fraction of a second, but in accordance with the motto of the Royal Astronomical Society of London, "Quicquid nitet notandum"—Whatever shines is to be noted.

SPEEDING IN THE SKY

By William Gifford Hale

SPEED is the thrill of the modern age. Speeding in swift cars, rushing trains, air-conquering planes. Lindbergh's spectacular rush across the Atlantic thrilled the whole world with the realization of a new era in space conquest, and speeds of two or three hundred miles an hour have been attained.

But suppose we found ourselves in a car travelling at double, treble, aye, ten times that speed, and were told that that car could never be stopped until it was burnt up or knocked to pieces, we should surely start up in alarm. Yet we are in just that position. For, listen to the tick of that clock: One, two, three, four, five. In those five seconds we have travelled a hundred miles. At that rate an airplane would encircle the world, not in twenty days, but in twenty minutes. And at this terrific speed we are being shot through space. Our car is the earth, and from it we cannot escape. And most certainly it will never stop until it either falls into the sun or collides with some other world.

But if you should get off it—suppose that one fine evening this old world of ours were to spin away without you, leaving you hanging in space—empty space, without a thing to stand on, you would just have to curl up and wait for the world to come round again, and if you kept your place she would not fail to call for you in twelve months' time, bumping up against you with a vengeance.

If the earth did leave you in the lurch, what would you see? Your first sensation, as the earth spun away from under your feet, would be that of rapidly rising in the air. The blue sky would swiftly darken to violet, and then become absolutely black; and an intense cold would assail you. Your bird's-eye view would rapidly widen as if by magic, the horizon expanding until you would see—first your whole county, then your entire state, then the whole huge continent of North America, and finally the great curving side of the world. Now for the first time in your life you would realize

that you had all your time been living on a huge ball, just like a fly walking about on an orange.

All at once, with a strange thrill, you would see that that great majestic globe was retreating from you, rapidly shrinking in apparent size as it rolled away into distant space, diminishing first to the size of the full moon, then to that of a brilliant green star.

Now, see, all around you—above your head, beneath your feet—on every side, extend the fathomless depths of space, gemmed with stars by the million, shining in a coal-black sky, and the sun blazing away amongst them, but not in the least drowning them with his glare, an electric-blue dazzle now, for the air, the atmosphere that on earth veils these lesser lights of heaven with the bright blue sky of day, that atmosphere has gone with the earth, and nothing now remains to dull the brilliance of the stars.

And what stars! Stars of every imaginable hue, from the intense blue-white of the electric arc, through every shade of colour, of clear translucent green, bright golden yellow, and orange, to red, deep crimson, and round to violet—stars of every tint known to men. There they are, glowing with steady unwinking radiance, twinkling no longer; for twinkling, too, is mostly an effect of the air. Infinitely far removed from us seem those gleaming points of light, and impassively still, their very distance masking tremendous velocities, for so far away are they that a hundred years makes but the smallest shift of their position among the other stars in the sky. That applies to all of them but a half-a-dozen, and those are what we call the "planets."

For, as you watch the receding earth sweeping out its mighty curve around the sun you become aware that amongst this host of apparently unmoving stars there are a few in visible movement, circling round the sun like the earth, some nearer the solar orb, like Venus, the beautiful evening star, and Mercury the swift—while others are farther away, like the mighty planet Jupiter, and Saturn the ringed planet.

But now turn your gaze to the sun himself, monarch and father of these planets. His unveiled splendour is a revelation of fresh glories in the sky. His golden glow is now replaced by a steel-blue dazzling as of a furnace "seven times heated," the radiant circle

of his incandescent disc is rimmed by a quivering crimson ring of shooting restless flame, while far out on either side of him, stretches, like vast wings, the pearly green corona; and far beyond that again the ghostly silver pyramids of the zodiacal light. Around this great source of light, heat and life, we watch the now distant earth swing. A million times bigger than our world, a might roaring furnace of heat unimaginable, is the sun. But so far out from him does the earth's path lie that it is safe from being burned up, and so immense is the world's annual journey that an airplane flying 100 miles an hour would take 600 years to get around the track the earth covers every year! Forty times faster than rifle bullet flies our world through the great void of the skies. Held in its path by the tremendous "gravity" pull of the sun, which is as strong as if wire cables were fastened from every point of the earth's surface to the sun, the world, enormous as it is, cannot break away and fly off into outer space, but can only swing round and round for ever, like a ball whirled round at the end of a string. And yet the immense globe of our world is so delicately poised that it responds instantly and continuously to the ever-varying pull of each of its sister planets—from the most distant Neptune, and unknown planets beyond—as they come nearer and attract it more strongly, and again swing farther from us in their never-ending race around the sun.

And now we look again from our imaginary perch in space, at the far-away earth now swinging round beyond the sun. We see it sweep out from behind him, and curve round to the left, growing more and more brilliant as it begins its homeward run to the point it left us at six months ago. With undiminished speed of nearly 20 miles a second it races towards us. Nearer it comes, accompanied by the moon—a small white star—waltzing around it as it spins along, covering two million miles a day. And now from a distant star it brightens and brightens, then grows to a disc, and then to a globe, rapidly swelling in size, and hiding more and more of the heavens behind its increasing bulk. Gliding majestically through space—"hanging upon nothing," as Job so graphically puts it—comes the great world, slowly turning upon itself like an immense top, until we see the continents become clearly outlined, with the

blue seas between crossed here and there by shining belts of white cloud, and capped north and south by the glittering snowfields of the poles. Now so close has it come that the immense "circle of the earth" fills all the sky on that side, from zenith to nadir, and the whole world rushes at us at a thousand miles a minute. At last our approach becomes to us, a fall towards the great looming globe, as the air swirls up around us again; the sun turns golden and the sky blue, and the stars vanish from sight. We descend to the ground, and Mother Earth reclaims her child. Such is our first view of the heavens from outside our native world, our first glimpse of the infinite universe that so closely wraps us round.

Seattle, Washington, U.S.A.

REVIEW OF PUBLICATIONS

La Théorie de la Quantification dans la nouvelle Mécanique. By Louis de Broglie. (Paris, Hermann, 1932. Price, 70 frs.)

There are, roughly speaking, three methods of approach to Quantum Mechanics according to present theories: Heisenberg's matrix mechanics, Dirac's abstract theory of states and observables, and the derivation of the wave equation by means of optical analogies which emphasize the connection between waves and particles. In the first two methods, which are more akin to each other than to the third, the wave equation appears during the development of the transformation theory, and the optical analogy is only incidental. The last method provides a short cut to the wave equation—which is all that is required for many problems—but a more general theory introducing matrices or operators is necessary if a thorough understanding of the general principles underlying Quantum Mechanics is to be achieved. Professor de Broglie adopts the last-mentioned line of approach, but by extending the original conceptions his final point of view is almost as general as that reached by the other two methods. Granted that this is to be the mode of approach, the presentation is, as might be expected, extremely good, and is, moreover, distinguished for its thoroughness and attention to mathematical rigour.

After an introductory chapter in which the Bohr theory is briefly summarized, the first part of the book is concerned with the derivation of the wave equation by the above-mentioned method and the physical interpretation of the wave function; applications are made to the harmonic oscillator, the rotator, and the hydrogen atom. The second part of the book is the most important and develops a general theory of quantization. Four chapters are devoted to a full discussion of the preliminary mathematical theory

of real and complex vector spaces and function spaces. A particularly welcome feature here is the treatment of continuous matrices and the Dirac δ-function, which is developed with far more thoroughness and rigour than is usual in presentations of the subject. The operators corresponding to any quantity (not merely the energy) are then introduced, and their associated matrices. An omission was noted on p. 162, where it is stated that all matrices in Quantum Mechanics are Hermitian, without mentioning that this is only true for matrices representing *measurable* quantities.

The physical interpretation of the theory is laid down in two general principles of the usual form, relating to the possible values which may be experimentally assigned to any quantity and the relative probabilities of finding these values for any given state of the system. The distinction is emphasized between what are termed complete and incomplete operators. Chapters then follow on mean values in Quantum Mechanics and the uncertainty principle, an exact statement of the latter being obtained but no experimental illustrations being given. The concluding chapters are devoted to a discussion of "first integrals", defined as functions of the dynamical variables whose matrices are independent of the time (*i.e.*, those which are usually termed constants of the motion), and the extension of the theory to include quantities which involve the time explicitly.

It will be seen from this that the author is concerned almost exclusively with the general principles underlying Quantum Mechanics rather than with applications to specific physical problems. No mention is made of perturbation theory, or more advanced topics such as spin and relativity. The student anxious to obtain a knowledge of the principles of the subject as quickly as possible with a view to the physical applications will perhaps turn elsewhere, but to those desirous of delving more deeply into the mathematical foundations, this book, written by one of the earliest pioneers in the field, should undoubtedly prove of considerable interest and value.

A. F. Stevenson.

The following are four small but authoritative recent publications by Hermann, Paris, the typography being excellent—as usual. To appreciate them they demand considerable knowledge of mathematics and physics.

L'Idée générale de la Mécanique ondulatoire et de ses premières Applications, par Marcel Boll. 74 pages, $5\frac{1}{2} \times 7\frac{3}{4}$ in. Price 15 frs.

Exposé électronique des Lois de l'Électricité, par Marcel Boll. 72 pages, $5\frac{1}{2} \times 9$ in. Price 15 frs.

Relations d'Incertitude, par Louis de Broglie. 24 pages, $6\frac{1}{2} \times 10$ in. Price 6 frs.

L'Existence du Neutron, par Irène Curie et F. Joliot. 22 pages. $6\frac{1}{2} \times 10$ in. Price 6 frs.

The first pamphlet describes in as simple a manner as possible the new conceptions which have revolutionized physical theories in recent years. Its chapters are: The bond between optics and mechanics, The uncertainty relations, Energy levels, Valence and chemical affinity, Electrical conduction in metals. The treatment is brief and demands considerable thought.

The second publication aims specially to assist those who teach elementary electricity and engineers who live in daily contact with the electric current. The chapters are: General properties of the electron, Laws of the electric current in metals, Electromagnetism and dynamic induction, Self-induction and natural frequency, Power—active and reactive, Static induction and radioelectricity. The treatment is condensed but clear.

The last two booklets are numbers 1 and 2 of a series of expositions of theoretical physics published under the direction of Louis de Broglie. The names of the distinguished authors are sufficient assurance that the treatment is authoritative.

The house of Hermann is to be congratulated for its steady stream of scientific works of superior quality. C.A.C.

NEWS AND COMMENTS

Dr. D. H. Menzel, astronomer at the Lick Observatory, has been appointed assistant professor of astrophysics at Harvard University.

The Rev. J. P. Rowland, S.J., has been appointed director of Stonyhurst College Observatory, England, succeeding the Rev. E. D. O'Connor, S.J., who has become rector of the college.

Miss Adelaide Ames, research assistant at Harvard College Observatory since 1923, was drowned in a canoe accident at Squam Lake, New Hampshire, on June 26. In co-operation with Director Shapley, Miss Ames had been carrying on important investigations of the extra-galactic nebulae.

Dr. Harold Jacoby, head of the department of astronomy at Columbia University prior to his retirement in 1930, died at the age of sixty-seven years.

Messrs. C. T. Elvey and T. G. Mehlin, of the staff of the Yerkes Observatory, spent the summer in the Davis Mountains, Texas, making observations to aid in selecting a suitable site for the new astronomical observatory of the University of Texas, for which a fund was provided by the late William McDonald of Paris, Texas. The observatory is to be erected by 1938, and it will have an eighty-inch reflector. Director Otto Struve of Yerkes Observatory, will also have charge of the new observatory.

The sixty-one inch reflecting telescope of Harvard University's new Oak Ridge observatory, at Harvard, Massachusetts, is expected to be in operation before the end of the year.

The formal opening of the Canadian National Research Laboratories, Ottawa, took place on August 10, in the presence of some 2,000 invited guests. The building is located near the Ottawa River where it is joined by the Rideau. It is a magnificent four-storied structure of about four million cubic feet in volume.

Dr. Frank Schlesinger, director of the Yale University observatory, was elected president of the International Astronomical Union,

at the recent meetings held at Cambridge, Massachusetts. The next meeting of the Union will be held in Paris, in 1935.

Director M. Esclangon of the observatory of the University of Paris, has been elected a member of the Bureau of Longitudes, succeeding the late M. Bigourdan.

Members of the Royal Astronomical Society's tours, visited the Dominion Observatory, Ottawa, on July 30 and August 23.

Professor F. J. M. Stratton, director of the Solar Physics Observatory, Cambridge University, England, paid a visit to the Dominion Observatory on September 27. REDeL.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Death of Max Wolf.

Astronomers in many countries have learned with regret of the death of Dr. Max Wolf, which occurred on October 3. He was in his seventieth year. Dr. Wolf was director of the Koenigstuhl Observatory and professor of astronomy in the University, Heidelberg, Germany, and was one of the best known of photographic astronomers. His kindly, generous nature won him a large circle of friends.

The Point of View.

"People of various types have already asked themselves by what logic does Sir James Jeans prove that God is 'a mathematical thinker?' One is inevitably reminded of the Greek philosopher who surmised that if horses had a god it would probably be a horse."—G. S. Brett, in a book review in *University of Toronto Monthly*.

The McDonald Observatory of the University of Texas.

In the year 1926 William J. McDonald, a banker of Paris, Texas, died and, although it was not known that he was specially interested in astronomy, yet in his will he bequeathed nearly a million dollars for erecting and equipping an astronomical observatory for the University of Texas. Litigation followed and the fund was somewhat reduced, but there is now on hand about $840,000 for the purpose named.

For some time the Yerkes Observatory has felt the need of a large reflecting telescope, and now an agreement has been reached between that institution (or rather the University of Chicago) and the University of Texas whereby the McDonald fund will be used for the construction of the telescope and of the necessary buildings and also for a part of the yearly expenses. The observatory will be the property of the University of Texas, but the University of Chicago will pay the salaries of the staff. It is expected that an assistant director, two assistants for observations, an engineer and a janitor will reside permanently at the observatory. The director

of the Yerkes Observatory will also be director of the McDonald Observatory. The aperture of the new instrument has been set at 80 inches and it will be located on a peak in the Davis Mountains in the south-west part of Texas, where astronomical conditions are declared to be excellent.

CHARLOTTE BRONTË'S DESCRIPTION OF THE AURORA BOREALIS.

It is interesting to recall the description of the Aurora given by Charlotte Brontë, one of the great mistresses of English style. The passage in found in "Villette", Chapter 26. The heroine of the story, Lucy Snowe, is in Brussels. She has just buried a packet of letters from a man, who, she now knows, loves another. The Brussels evening reminds her of one experienced in England on the Yorkshire moors:—

"The air of the night was very still, but dim with a peculiar mist, which changed the moonlight into a luminous haze. In this air, or this mist, there was some quality—electrical, perhaps—which acted in strange sort upon me. I felt then as I had felt a year ago in England—on a night when the aurora borealis was streaming and sweeping round heaven, when, belated in lonely fields, I had paused to watch that mustering of an army with banners—that quivering of serried lances—that swift ascent of messengers from below the north star to the dark, high keystone of heaven's arch. I felt, not happy, far otherwise, but strong with reinforced strength." —C.V.P.

FUTURE ECLIPSES IN THE UNITED STATES AND CANADA.

In a recent number of *Science,* Charles H. Smiley, of Brown University, gives the following information regarding the next four total eclipses visible in the United States and Canada. They occur in 1945, 1954, 1959 and 1963.

For the eclipse of July 9, 1945, the moon's shadow will strike the earth at sunrise just north of Boise, Idaho. It will sweep across Manitoba, passing near Winnipeg, across the northwestern section of Ontario, over Hudson Bay and across the northern part of Quebec. For a point just south of Hudson Strait, the duration of totality will be about a minute. The sun will be about 24° above the horizon there.

For the eclipse of June 30, 1954, the moon's shadow will strike the earth at sunrise in north central Nebraska. It will pass over Lake Superior, going near the southern end of James Bay and on out near the southern tip of

Greenland. For a point in Northern Quebec, the duration of totality will be about two minutes. The sun will then be about 27° above the horizon. For the eclipse of October 2, 1959, the moon's shadow will strike the earth at sunrise in southern New England and will move at once out over the Atlantic Ocean.

For the eclipse of July 20, 1963, Oppolzer's elements indicate that the moon's shadow will come down out of the northwest, passing near the southwestern edge of Hudson Bay and James Bay, crossing Maine near Belfast. The accurate computations made at the American Nautical Almanac Office were based on modern elements and consequently their determination of the path of totality of this eclipse will be much more accurate than this. It is interesting to note that, though the maximum duration of totality for the eclipse as given by Dr. Robertson is 100 seconds, the duration of totality for points in Maine will be in the neighbourhood of 70 seconds. In this connection, it may be mentioned that for a point in Maine, Oppolzer's elements indicate a duration of totality of 113 seconds instead of 98 seconds as predicted on the basis of modern elements.

For points in Maine, totality in the 1963 eclipse will begin about 5.40 p.m. Daylight Saving Time, but because it will be near the middle of the summer, the sun will be almost as high above the horizon as it will be at Fryeburg, Maine, at this year's eclipse.

ECLIPSE "OBSERVATIONS" AT LOUISEVILLE.

About fifty members of the Royal Astronomical Society of Canada gathered at Louiseville to view the eclipse of the sun on August 31. They were courteously received by the mayor of the town and assigned a convenient location at one end of the agricultural fair grounds. At the other end the French expedition, led by Count de la Baume Pluvinel, had erected their instruments behind a close board fence which protected them from intruders. Between the two parties were the sheds for housing the cattle.

Observation 1. "Yonder is France, here is England, with the Milky Way between."

One of the party was Mr. Andrew Thomson, physicist of the Meteorological Service. His business was to record the electrical condition of the atmosphere. Looking for something to set his electrometer on, he espied in the distance an ancient cart, or what was left of it—two wheels, the axle and the shafts. Running over to it he got between the shafts and trotted back with it.

Observation 2. "That's observing *à la carte.*"

Observation 3. "He's the man who put the 'as' in astronomy."

C.A.C.

MEETINGS OF THE SOCIETY

AT WINNIPEG

February 10, 1932.—The regular monthly meeting of the Winnipeg Centre was held at 8.15 p.m. The president, Dr. Maclean, was in the chair.

The following were elected to membership in the Society: Mrs. J. F. Horrocks, 520 Gertrude Ave., Winnipeg; Mr. Liston McIlhaggo, 134 Chestnut St., Winnipeg; Mr. L. T. S. Norris-Elye, 158 West Gate, Winnipeg.

The speaker of the evening was Mr. D. C. Archibald, M.A., M.Sc., Superintendent of Western Airways Forecasting Service. The title of his address was "Weather".

"The composition of the atmosphere, including the lower and upper portions, termed the troposphere and stratosphere, was first considered by the speaker. The atmosphere forms a relatively thin layer when one considers the size of the earth. If the earth is represented by a globe eight inches in diameter, the thickness of the atmosphere on the same scale is only about one-tenth of an inch.

"Methods of investigating meteorological phenomena by means of balloons—both manned and free—and also by means of airplanes, were discussed. The range of atmospheric temperature experienced on the planet earth is covered by 200 degrees Fahrenheit, from the great cold of the arctic regions at one end of the range to the sweltering heat of the tropical regions at the other.

"Temperature varied with height. Strange to say, it was found that coldest temperatures existed vertically above the equator, while at the same height above the earth's surface, in higher latitudes, warmer temperatures were experienced.

"Of particular importance to aviators was the relation of wind velocity and direction with altitude. Methods of observation and means of transmitting meteorological information to the pilot were explained.

"Forecasting weather is a scientific process, based upon physics and soundly sifted experience. It cannot be successfully accomplished either by reading the legends around a weather glass or by appeal to rhymes and maxims of weather lore."

The lecture was fully illustrated by slides.

S. C. Norris,
Secretary.

AT TORONTO

March 22.—The meeting was held in the usual place at 8.00 p.m.; Mr. R. A. Gray in the chair.

Three persons were duly elected to membership in the Society:—

H. G. Duncalfe, 150 Wright Ave., Toronto.

Henry Bowers, 22 Copeland Ave., Toronto.

Blake B. Fox, 2825 Algonquin Pkwy., Toledo, Ohio.

An exceptionally large audience greeted Professor Lachlan Gilchrist, second vice-president of the society, whose topic, "Electrons, Protons, X-Rays and Cosmic Rays", was of considerable interest at a time when the discovery of the "neutron" and important advances in our knowledge of the cosmic ray had just been publicly announced.

Dr. Gilchrist outlined the developments which have taken place in the study of electrical discharges in rarefied gases and traced the contributions of Röntgen, Professor and Madame Curie, Becquerel, Sir J. J. Thomson, Lord Rutherford, R. A. Millikan and others to our knowledge of X-rays, alpha, beta and gamma radiations, and the disintegration of uranium, thorium, radium and other radioactive elements. Of particular interest was the description of the recent experiments at the University of Giessen, when cosmic rays were artificially produced for the first time by Professor W. Bothe and Dr. H. Becker. Beryllium atoms were bombarded with alpha particles, or helium nuclei, from the radioactive element polonium and gave off artificial cosmic rays, the beryllium atom itself being changed into a hitherto unknown isotope of carbon, a carbon atom with an atomic weight of 13. Recent research by Dr. James Chadwick at Cambridge, England, reveals that the cosmic ray may be a flood of neutrons, a combination of the positively charged proton and the negatively charged electron, but with no charge at all. The address was illustrated by a series of very interesting experiments demonstrating electrical discharge in rarefied gases, and the use of the electroscope in studying the effects of the X-ray and other related phenomena.

FRED L. TROYER,
Acting Recorder.

AT LONDON

March 11.—A regular meeting was held at 8.00 p.m. in the London Life Building. There were 48 members present. A study of the constellations Cancer, Leo, Virgo was conducted by Rev. R. J. Bowen. Dr. H. S. Wismer exhibited a sextant which he had procured for the evening, and explained the construction and use of the instrument.

President McKone next introduced Dr. R. C. Dearle, Head of the Department of Physics, University of Western Ontario. The subject of Dr. Dearle's address was "Relativity and the Astronomer". The speaker pointed out that there are two branches of the theory of relativity; the first, known as the Restricted Relativity Theory has gained the most prominence and was created to solve certain problems arising in physical laboratories. The second branch, known as the General Relativity Theory, grew out of the first branch. The Restricted Relativity Theory is based on the principle of relativity, which asserts that if a set of natural laws are obtained from the results of a series of experiments on

natural phenomena, the experiments referred to a fixed coordinate system, then exactly the same set of laws will be obtained if the experiments are referred to a coordinate system which moves uniformly with respect to the first system.

Dr. Dearle described the Michelson-Morley experiment to measure the ether drift, and then explained the later deduction by Fitzgerald and Lorentz, namely, an object in motion shrinks in the direction in which it is moving. This result establishes the theory of restricted relativity. The principle of relativity leads to a variable light velocity, which is at odds with Einstein's postulate that the velocity of light in vacuum is invariant. Einstein maintains that there is no absolute frame of reference for motion, and he has pointed out that the contradiction between his postulate and the principle of relativity lies in the fact that the Michelson-Morley experiment, with the further conclusions of Fitzgerald and Lorentz are based on the assumption that ether is in rest and that it is possible to measure motion relative to it.

The speaker described the Fizeau experiment which found changes in the velocity of light. The General Relativity Theory was next discussed. This particular branch of relativity abolishes the uniform velocity of translation between the two frames of reference, and substitutes a perfectly general transformation from one set of coordinates to the other. The General Relativity Theory is essentially a mathematical achievement which involves certain consequences of great interest to the physicist. In particular, the theory shows that a ray of light passing through an intense field of gravitational potential is bent. In physical laboratories this bending is too minute to be measured Photographs taken during the total eclipse of the sun of 1919 showed conclusively that a ray of light which passes close to the sun is bent, the observed angular deviation agreeing closely with the calculated results. The General Relativity Theory gives an adequate explanation of the variation in the position of the perihelion of Mercury. In conclusion Dr. Dearle pointed out that Professor Miller of Case School of Applied Science, who is still carrying out the Michelson-Morley experiment, reports consistently certain results which, if valid, deny the theory of relativity.

G. R. Magee, *Sec.-Treas.*

AT VICTORIA

The Eclipse of August 31st

September 22, 1932.—The Victoria Centre of the Royal Astronomical Society of Canada opened its fall series of meetings last evening when Mr. W. E. Harper, Assistant Director of the Observatory, spoke on solar eclipses in general, dealing more specifically with the recent one. While actual measures of the photographs secured by the successful expeditions will not be available for some months, some general conclusions seemed to be warranted from the preliminary results to hand.

The ionizing agent for the Kennelly-Heaviside layer in the upper atmosphere of the earth, which layer and one even higher up at 230 kilometres

makes possible long distance radio communication, seems to be ultra-violet light from the sun. At the time of eclipse there was a return to night radio conditions in the eclipse path, showing that whatever the ionizing agency might be, it must have the velocity of light. This study has a practical bearing for radio direction signals at sunrise and sunset are at present unreliable.

After quoting from early Chinese, Biblical and Greek sources of the effects of such eclipses upon the people, the speaker went on to show what information had already been secured from the eclipses of the past hundred years. The discovery of helium in the flaming gases shot out from the sun led to its discovery later on the earth. The nature of the gas responsible for the long coronal streamers surrounding the sun is yet unsolved, although a few weeks ago it was suggested that oxygen in an unusual form was the cause. Since the war the problem of seeing whether stars in the immediate vicinity of the sun are apparently displaced in position, in line with Einstein's theory, has occupied considerable attention.

The present eclipse was of short duration, being only 100 seconds at the central line. The shadow cone struck the earth beyond the north pole, traversed the northern regions of Canada, southeastward through northern Quebec, thence crossing the St. Lawrence, 50 miles east of Montreal, to continue through the New England States, eventually leaving the earth in mid-Atlantic. Fully fifty well-equipped expeditions lined the central line of totality, about fifty per cent. of them having clear skies and securing results. The Greenwich party were located at Parent, Quebec, and were partially successful. The University of Toronto expedition had cloudy skies, but the group of amateur astronomers representing the Toronto Centre of the R.A.S.C. had clear weather at Louiseville, and are reported as having photographed the "shadow bands" seen just before and after totality. Such has recently been tried, but never successfully to date.

Expeditions from the Lick and Mount Wilson Observatories, were located at Fryeburg and Lancaster. The former had clear weather and secured some good photographs and spectra. The large camp at Magog, Quebec, where Mr. Harper and Dr. Beals of the local observatory were assisting, had about the last word in equipment, but owing to cloudy skies no scientific results of value were secured. Sixty instruments, big and little, were set up on the golf course of the Country Club of Magog, and astronomers mostly from England, but from Holland, Belgium, the United States and Canada were also there. Mr. Harper described, with the aid of lantern slides, the equipment at Magog, and pictured the scene during the approaching shadow and its departure like a mighty thunder-cloud moving with terrifying rapidity. Though downcast, the astronomers accepted their defeat with philosophic calm and hoped for better luck next time.

Commercially, the eclipse had been much boosted, and many hundreds of thousands of people made their way that day into the zone of totality

which was only one hundred miles in width. All trains and airports and excursion steamers reported a busy day. In a jocular way the speaker referred to the indifference shown by four ladies from Montreal who had taken passage on the eclipse excursion steamer to view the eclipse and who preferred to play bridge below decks while Nature was putting on the "big show" above.

OTHER ECLIPSE REPORTS

It is convenient to introduce here some other reports sent to the Editor.

WALTER J. HELM, of Port Hope, Ont., at Maskinongé.

At about 2.30 p.m. we left the car at the highway and walked north some distance until we reached high land commanding a fine view of the entire countryside. We were well away from all traffic. The sky generally was cloudy, but there were patches of blue here and there and it made the watchful waiting all the more tense.

Just before the first point of contact, there was a fine, clear blue space around the sun so that we saw that part perfectly. From then on we watched it with increasing fear that at the last moment the clouds would cover the sun at totality, but about five minutes before it, the clouds passed over and left the sun again in clear blue sky with plenty of margin, so that from about five minutes before totality the sky was practically clear and we saw it, I think, to the best possible advantage.

There was a small patch of pine trees close by us on the left with some odd spruce trees scattered about quite close to the hill on which we stood, and we witnessed the crows beating it home to roost with some cranes heading as hard as they could go south to the St. Lawrence and some smaller birds in the trees twittering as they do at nightfall.

I do not know how the corona compared with previous ones, but there was one particularly long shot of flame at the top left of the sun. Jupiter was quite bright, close to the sun at the right, and altogether it was a glorious experience which I appreciate all the more, knowing that so many were disappointed who had worked so hard and who had come so many miles to see the spectacle.

H. W. BARKER, of Toronto, at Louiseville.

My particular job during the eclipse was two-fold, (1) To time the appearance of the shadow-bands, and (2) To identify the stars and planets.

(1) I had my watch set, second-hand as well as hour hand, at noon on the day of the eclipse; and then, aided by a stop-watch, which I started at 4.11 Eastern Daylight Time, I timed the first appearance of the shadow-bands. Provided my observation was correct, and I think it was, the time was found to be 4h. 22m. 19s. If totality began at 4h. 22m. 34s. (and I believe this was checked by other members of the party) the shadow-bands made their appearance just fifteen seconds before totality.

(2) I must confess that I was so much attracted by the beauty of the corona that I did not give as much attention as I should have done to the stars and planets. Jupiter, however, was very clear, but its position was further to the right of the sun than that shown on the charts prepared beforehand.

You will see that my conclusion that the shadow-bands appeared fifteen seconds before totality (or at 4h. 22m. 19s. Eastern Daylight Time) is based on the correctness of the prediction that totality would begin at 4h. 22m. 34s. I think it was Professor Beatty, but I am not sure, who checked the time of the eclipse. Someone told me, however, it was reported that the first contact was some few seconds late, and if this is so it is more than likely that the beginning of totality was also a few seconds late. If so, the number of seconds will have to be added to the fifteen.

And now, a word about the corona and the prominences. The moving pictures taken by Mr. Milne of Hamilton, which I have seen, to my mind do reasonable justice to the corona. They confirmed my impression that the corona was not a steady halo as shown in so many photgraphs (the result, no doubt, of a long exposure), but was streaked, giving the appearance of white, feathery wings, and suggesting motion. These streamers looked to me to be radiating or flowing out in pointed, slowly shifting masses from the central sphere, and extending from the sun's equator a diameter or more, but a comparatively short distance from the poles. As the moon advanced from right to left over the face of the sun, it looked as if the corona-stream was forced out on the opposite side, and it is made clear in Mr. Milne's moving pictures that this was precisely what happened. For example, at the beginning of totality the streamers, to my view, extended further to the left than to the right of the sun, and toward the end of totality these wing-like appendages seemed to reach out more to the right than to the left. At no stage, however, did they extend anything like as far from the poles as they did from the equator. I might add that in general form the corona appeared a good deal like that shown in Ball's "Story of the Sun", p. 278, Plate X, top picture, taken in 1878—also a time, I believe, of minimum sunspots; but the appendages on August 31 were not quite so definitely marked, and instead of being a soft yellow or buff colour, as in the picture, they were white.

As to the prominences, these appeared to me to be like flames shooting out here and there from behind the black ball, and *these flames gave the only colour visible in the whole setting.* The lower picture on p. 278 of Ball's book shows the prominences much as I saw them.

F. K. DALTON (with J. C. Burkholder) of Toronto, near St. Simon.

It had been our intention to view the eclipse at Actonvale, but after lunch we studied the road map to find a shorter course to the centre line of the path, and decided to change our direction slightly and take the Drummondville road.

It was well that we made this change, for as we left St. Hyacinthe, we noticed only one blue patch of sky, a few miles to the east, and this highway soon turned in that direction, so that in about fifteen minutes we were in sunlight under a perfectly clear sky near St. Simon (Co. Bagot). It was now 2.05 p.m., and the eclipse was due to start in nine minutes.

We observed first contact, right at the scheduled time, and followed the progress of the initial partial phases for the first fifty minutes at this position. During this period, when the sun's disc was about half covered and the reduction in light could be realized, we noticed a group of cows stop grazing and start slowly, in procession, for the barn.

The oncoming cloud bank was moving at the rate of about three miles per hour and now (3.00 p.m.) had just reached the sun, so we moved about two miles farther east along the highway. Here, we were in clear sunlight again, so we observed for a few minutes and then moved still further on, nearer to the receding cloud shadows on the east side of the patch of blue sky and here, one mile south of St. Hugues, at about 3.15 p.m., we prepared to view the eclipse during totality. We were not disappointed: we viewed the whole magnificent spectacle in a perfectly clear sky and secured a few photographs.

Just as the last trace of the sun disappeared, 3.24 p.m., the prominences and the wide bluish corona became visible. The moon itself was also bluish, apparently illuminated by reflected light from this earth. Jupiter was visible, slightly to the west, and also a few stars, but Mercury was hidden by clouds and Venus had just set.

Everything about us now was illuminated by a queer dim bluish light. With a photo-electric cell we measured the intensity, which was 0.50 foot-candles. Some crows were rather puzzled and flew to the woods: a rooster crowed lustily.

Totality lasted about 90 seconds, and then the sun burst forth at just one point on the west edge of the moon. The eclipse now resembled a solitaire diamond ring with the stone glowing brilliantly. Its brilliancy increased very rapidly and in a few seconds, through our shields, we saw the crescent reappear,—and the great display was over.

H. S. McCLUNG, of Regina, Sask., at Regina.

Having just watched through a telescope the last notch of the eclipse disappear (1.56½ M.S.T.) I am at once recording the only unexpected feature that I observed. At the very ends of the slender "bite" taken out of the sun by the moon there seemed to be small tufts of more intense light than on the sun's limb just below and above, or along the moon's limb between the ends of the "bite". I thought it might be an optical illusion, but when I closed my eyes, rested them, and then looked again, the tufts of light were still there each time.

I should appreciate an explanation.

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